5 Discussion

This preliminary investigation has attempted to identify and categorise the range of clinical phenomena that may be related to environmental exposure from the M5 East stack. These phenomena are predominantly eye irritation, and to a lesser extent nose, throat, headache and chest symptoms. It has provided NSW Health with baseline information for further epidemiological investigation (Phase 2). While this phase is of a preliminary nature, it was found that:

- A large proportion of participants presented with eye symptoms with an onset temporally related to the opening of the tunnel, and constant nature, varying only when the participants left the area.
- Many of the participants had others members in their household that did not appear to be affected, raising the issue of variation in individual sensitivity to the possible environmental exposures.
- The participant's allergy status was not related to their assessment category, with the atopy prevalence of those in 'Category A' appearing lower than normal.
- The participants were generally older, female, English speaking, from a range of education levels, and resided predominately to the north west of the M5 East stack. There did not appear to be significant indoor sources of air pollutants to explain the symptoms in most participants.
- The general health of the participants tended to be lower than the expected norms as measured by the SF-36, except for mental health which was almost average.
- Women were one and half times more likely to have 'Category A' symptoms as men.

This study can make no inference about the actual 'cause' of the symptoms being experienced. It remains for an analytical study to prove or disprove whether or not there is an association between eye and respiratory irritation and living close the M5 East stack.

The sampled group was not randomly selected, and was deliberately biased towards those people who were most likely to be affected. Whilst the recruitment strategy was broad and we attempted to minimise reasons people would be unable to participate, it is likely that people who were ill, elderly or non-English speaking were less likely to participate. There may therefore be people in this population that are more symptomatic than the sampled group. People living in the area may also have been either more or less likely to participate in an investigation run by a government department depending upon their past experiences and belief systems.

It is interesting to note that the symptoms reported by the participants have similarities to those of 'Sick Building Syndrome' (SBS). In the current World Health Organisation Air Quality Guidelines SBS is defined as the occurrence of specific symptoms with unspecified aetiology, which are experienced by people while working or living in a particular building, but which disappear after they leave it. Symptoms include mucous membrane, skin and eye irritation, chest tightness, fatigue, headache, malaise, lethargy, lack of concentration, odour annoyance and influenza symptoms. Volatile organic compounds (VOCs) were identified as a possible important cause of SBS. It was however conceded that SBS is probably an interaction of several factors, involving different reaction mechanisms. The causes of this syndrome may be as varied as environmental tobacco smoke, formaldehyde, VOCs, pesticides, odorous compounds, carbon monoxide, carbon dioxide, nitrogen dioxide, ozone, the surrounding temperature, relative humidity, ventilation rate, artificial light, noise, vibration, biological and psychological factors.[13]

Little is known about whether there are any health effects on eyes associated with the cumulative effects of low levels of pollutants. While individual compounds at this site do not exceed (or approach) recognised threshold levels for irritative effects, the cumulative impact of several subthreshold pollutants has been associated with eye irritation. Studies by Hempel – Jorgensen et al on VOCs and the eye have noted a clear association between the cumulative impact of mixtures of VOCs and increased eye irritation.[14] Suggested mechanisms for this irritation included chemical stimulation of the trigeminal nerve

ending in the mucosal tissue of the eye, nose and throat stimulating sensations of stinging, burning tickling and pain.[15] Hempel – Jorgensen et al also explored the time course of sensory eye irritation. Evidence suggests that sensory eye irritation increases exponentially during the first 20 to 40 minutes of VOC exposure, after which a period of equilibrium is established. This equilibrium is believed to be brought about by a possible chemical balance in tear film and air concentrations of VOCs. It was noted that prolonged irritation persisted long after exposure ended and that stimulation of one eye would elicit a response in the contralateral eye.[16 17] In their review of three research papers, Okawada et al[18] established links between threshold levels of photochemical air pollutants and eye irritation, defined by the appearance of superficial keratitis. They recognised that tear lysozyme levels were reduced by photochemical air pollution with the main offender being ozone. A tentative link between photochemical air pollutants and reduced pH levels in tears was also established.

Increase in pollutant levels has been associated with increased rates of eye conditions.[19] Defined as Discomfort Eye Syndrome (DES), Versura et al undertook an investigative study of 100 DES patients, to estimate whether a relationship existed between subjective symptoms of discomfort, the intensity of possible subclinical eye inflammation and/or dryness and the degree of air pollution in relation to the subjects' living zone. They undertook this process by the objective testing of the tear film and ocular surface. Testing included Schirmer-I, Ferning test, Tear Break Up Time, Impression Cytology and Scraping Cytology. (Other testing may include Eye Redness, Epithelium Damage and Foam Formation.)[20] Living zones were classified into 3 areas – downtown, town suburbs and countryside. The investigative group found no correlation between tear instability and location of residence. A correlation was found between inflammatory responses, measured by cytology, and living zone. This was not affected by age or sex. A significant positive correlation was found between dryness and pollution, according to different living zones. Women were found to be twice as likely to suffer from DES as men. It was however conceded that the participants may have been susceptible to dry eye conditions with the pollutants aggravating rather than causing the eye irritation/dry eye.[19]

In her literature review on livestock odours, Shiffman identified four ways that odours (mainly from VOCs) could affect human health. These included:[21]

1. Direct toxicological effects, such as acute poisoning;
2. Odourous compounds causing sensory irritation of the eye, nose and throat. This was mainly believed to occur through direct stimulation of the trigeminal nerve.
3. VOCs stimulating sensory nerves to cause neurological changes. It has been hypothesised that neurological changes occur so that a person develops a chemically learned response.
4. Cognitive and emotional factors such as stored mental experience may stimulate a response. People perceive the odour as irritating based on past experiences.

While all four mechanisms were reviewed, the overwhelming health symptoms in all four cases were of eye, nose, throat irritation, headache and drowsiness.

Dust particles may also have a significant effect on eye and nose irritation. In their experiments on human exposure to airborne office dust Pan et al[22] showed a significant reduction in tear break up time owing to dust exposure. The results showed a significant correlation between perceived air quality and the reported symptoms of dry eyes, eye irritation, facial skin irritation, nose irritation and feeling stressed. At an acute level there was a significant correlation between perceived air quality and odour intensity, leading to the hypothesis that odour was a major indicator of air quality. However, no significant change was found between dust exposure and, nasal volume, epithelial damage and foam formation.

Environmental concern or worry has been associated with adverse health symptom reporting in communities exposed to sub threshold levels of pollutants.[23 24 25] In their review of three surveys around hazardous waste sites Libscomb et al[26] found a significant association between environmental worry and eye/skin irritation. Brender et al[27] adjusted for environmental worry in their survey of a community surrounding a wood treatment facility contaminated with polycyclic aromatic hydrocarbons (PAH). This adjustment reduced the relative risks of the three health outcomes measured (skin rashes, chronic bronchitis and difficulties becoming pregnant) with only skin irritation still remaining significantly associated with the exposure to PAH.

The prevalence of eye, nose and throat irritation in the community is difficult to quantify. Hempel-Jorgensen et al[28] noted in a study of 2060 Danes by Volbjorn et al, that the prevalence of work related mucous membrane irritation (irritation of the eyes, nose and throat) was 16% whereas 7% of the subjects reported having mucosal irritation at home. In a separate study, Skov et al[29] found that 20% of men and 32% of women had work-related irritation of the mucous membranes with 8% of the men and 15% of the women having work related eye irritation and 12% of men and 20% of women having work related nasal irritation. In Queensland, a cross sectional prevalence study was undertaken near the hazardous chemical waste site at Kingston and a control site at Beenleigh in order to identify possible health impacts. The following eye, nose and throat prevalence were established:[30]

	Kingston	Beenleigh
Percentage experiencing the symptom in the last 6 months		
Chronic eye irritation	34%	11%
Irritated throat / husky voice	49%	38%
Itchy nose	42%	32%
Percentage noting an increase since moving to….		
Eye irritation	36%	11%
Eye tearing	27%	4%
Eye grittiness	28%	4%

Finally, the South Australian Department of Human Services established a community prevalence rate of 40.9% for itchy eyes whilst investigating community health complaints around the Castalloy Manufacturing plant.[31]

Dry eye can be an underlying factor to a perception of eye irritation. The documentation available on and classification of the prevalence of dry eye symptoms in Australia is better than eye irritation. Even so, differences in diagnostic tests and their results, definitions of dry eye, age, gender and environment, make establishing the prevalence of dry eye in Australia difficult. In her analysis of 1584 subjects in Mackay, Queensland, Albietz established an overall prevalence of dry eye of 10.8%. The prevalence of marginal dry eye conditions accounted for another 7.3% bringing the total subject population with dry eye symptoms to 18.1%. She noted a marked difference in prevalence with age.[32] A separate cross sectional prevalence study undertaken by McCarty et al on the Melbourne population identified varying prevalence rates for the various diagnostic tools of dry eye[33]. In this study, the percentage of participants who self-diagnosed with a severe symptom of dry eye that could not be attributable to hay fever was 5.5%. In an American study on the elderly, Schein et al concluded that for a population over 65 years the dry eye prevalence was 14.6%[34] (as defined by the reporting of one or more dry eye symptoms as 'often' or 'all of the time'). When repeating this American study on a Taiwanese Chinese population Lin et al determined a prevalence rate of 23.5%.[35]

The tests used in the diagnosis of dry eye are similar to those for eye irritation. These include the Schirmer test, Tear Break Up Time, Impression Cytology, Epithelium Damage, Tear Assay and general slit lamp observation. At a subjective level the use of a questionnaire is standard procedure. Currently in Australia, the most commonly used questionnaire is the McMonnies dry eye questionnaire.

This suite of objective and subjective eye irritation investigations, along with the previous prevalence studies, opens the possibility of quantifying any effect of pollution in this area. It would be advantageous for future studies to also include environmental monitoring of volatile organic compounds, particulates and odours.

Conclusion

6

This study has provided a description of the health status of a group of 54 people residing in the Turrella area who have reported health effects they believe are related to the M5 East exhaust stack. The information collected is based largely on their perceived health status, symptoms and limited clinical tests.

While it is acknowledged that the classification of reported symptoms into categories of relatedness to exposure has been based upon reports of perception by each individual to the examining medical officers, the description of symptoms, likely contributing and triggering factors, and initiating events, have provided a base from which it should be possible to further our investigations to determine any relationship between the M5 East exhaust stack emissions and the health status of the local population.

Some options for further investigation include:

1. An analytical study with the aim of determining whether or not there is a real association between residential location and symptoms.
2. Should an analytical study demonstrate an association, an environmental investigation to better characterise pollutant exposure levels.

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